

**What is claimed is:**

1           1.    A method for forming bottle-shaped trenches,  
2   suitable for use in a dynamic random access memory  
3   (DRAM), comprising:

4           providing a substrate;

5           forming a hard mask having openings on the  
6           substrate;

7           etching the substrate through the openings to form  
8           trenches with a upper portion and a lower  
9           portion;

10          conformally forming a isolated layer in the trenches  
11          and on the hard mask;

12          forming a shield layer in the lower portion of the  
13          trenches;

14          removing parts of the isolated layer which is not  
15          covered by the shield layer to expose the  
16          surface of the upper portion of the trenches;

17          forming a protective layer on the sidewall of the  
18          upper portion of the trenches;

19          removing the shield layer to expose the isolated  
20          layer in the lower portion of the trenches;

21          removing the isolated layer to expose the substrate  
22          of the lower portion of the trenches; and

23          etching the substrate of the lower portion of the  
24          trenches using the protective layer as a mask  
25          to form bottle-shaped trenches.

1           2.    The method as claimed in claim 1, wherein the  
2   substrate comprises silicon.

1           3.    The method as claimed in claim 2, wherein the  
2    hard mask comprises a nitride.

1           4.    The method as claimed in claim 1, wherein the  
2    trenches are etched by an anisotropic etching.

1           5.    The method as claimed in claim 1, wherein the  
2    isolated layer comprises an oxide.

1           6.    The method as claimed in claim 5, wherein the  
2    isolated layer is formed by chemical vapor deposition  
3    (CVD).

1           7.    The method as claimed in claim 1, wherein the  
2    protective layer further comprises dopants.

1           8.    The method as claimed in claim 7, wherein after  
2    forming the protective layer further comprises driving  
3    the dopants into the substrate surrounding the protective  
4    layer by thermal treatment.

1           9.    The method as claimed in claim 1, wherein the  
2    shield layer comprises polysilicon.

1           10.   The method as claimed in claim 8, wherein the  
2    step of forming a shield layer in the lower portion of  
3    the trenches comprises:

4           forming the shield layer to fill the trenches;  
5           removing parts of the shield layer in the upper  
6           portion of the trenches to leave parts of the  
7           shield layer in the lower portion of the  
8           trenches.

1           11. The method as claimed in claim 1, wherein the  
2 shield layer is formed by chemical vapor deposition  
3 (CVD).

1           12. The method as claimed in claim 1, wherein the  
2 protective layer comprises a nitride.

1           13. The method as claimed in claim 12, wherein the  
2 protective layer is formed by chemical vapor deposition  
3 (CVD).

1           14. A method for forming bottle-shaped trenches,  
2 suitable for use in a dynamic random access memory  
3 (DRAM), comprising:

4           providing a substrate;

5           forming a hard mask having openings on the  
6           substrate;

7           etching the substrate through the openings to form  
8           trenches with a upper portion and a lower  
9           portion;

10          conformally forming a isolated layer in the trenches  
11          and on the hard mask;

12          forming a shield layer in the lower portion of the  
13          trenches;

14          removing parts of the isolated layer which is not  
15          covered by the shield layer to expose the  
16          surface of the upper portion of the trenches;

17          conformally forming a protective layer on the  
18          sidewall and the bottom of the trenches;

19          removing parts of the protective layer on the bottom  
20          of the trenches to leave parts of the

21                protective layer on the sidewall of the  
22                trenches;  
23                removing the shield layer to expose the isolated  
24                layer in the lower portion of the trenches;  
25                removing the isolated layer to expose the substrate  
26                of the lower portion of the trenches; and  
27                etching the substrate of the lower portion of the  
28                trenches using the protective layer as a mask  
29                so as to form bottle-shaped trenches.

1                15. The method as claimed in claim 14, wherein the  
2                substrate comprises silicon.

1                16. The method as claimed in claim 14, wherein the  
2                hard mask comprises a nitride.

1                17. The method as claimed in claim 14, wherein the  
2                trenches are etched by an anisotropic etching.

1                18. The method as claimed in claim 14, wherein the  
2                isolated layer comprises an oxide.

1                19. The method as claimed in claim 18, wherein the  
2                isolated layer is formed by chemical vapor deposition  
3                (CVD).

1                20. The method as claimed in claim 14, wherein the  
2                protective layer further comprises dopants.

1                21. The method as claimed in claim 20, wherein  
2                after formation of the protective layer, dopants are  
3                driven into the substrate surrounding the protective  
4                layer by thermal treatment.

1           22. The method as claimed in claim 14, wherein the  
2 shield layer comprises polysilicon.

1           23. The method as claimed in claim 14, wherein the  
2 step of forming a shield layer in the lower portion of  
3 the trenches comprises:

4           forming the shield layer to fill the trenches;

5           removing parts of the shield layer in the upper  
6           portion of the trenches to leave parts of the  
7           shield layer in the lower portion of the  
8           trenches.

1           24. The method as claimed in claim 14, wherein the  
2 shield layer is formed by chemical vapor deposition  
3 (CVD).

1           25. The method as claimed in claim 14, wherein the  
2 protective layer comprises a nitride.

1           26. The method as claimed in claim 25, wherein the  
2 protective layer is formed by chemical vapor deposition  
3 (CVD).